Independent claims 1 and 11 stand rejected as being anticipated by Tekalp. Applicants note that each of independent claims 1 and 11 calls for a particular type of motion estimation based on a dense motion field of a portion of the image sequence. That is, a type of motion estimation in which the estimate "is generated at least in part as a constrained function of a characterization of motion between elements of the dense motion field and elements of one or more other portions of the image sequence." Applicants have described the importance of the claimed constrained function arrangement in their specification at, for example, page 5, lines 5-18, as follows, with emphasis supplied:

> In conventional block-based video encoders, motion vectors are generally based on 16x16 or 8x8 blocks of pixels, since it has been determined that this amount of information can be coded in an efficient manner and sent to the decoder as side information. Although finer motion vectors, e.g., motion vectors based on 4x4 or 2x2 blocks of pixels or on single pixels, provide better prediction, it has heretofore generally been believed that the resulting increased amount of side information cannot be encoded efficiently enough to produce an acceptable level of compression.
>
> The present invention overcomes this problem by utilizing an MRF model which imposes a piecewise smoothness constraint on the motion field. This approach is appropriate since within a given object, it is expected that the motion will be uniform. By forcing the motion field to be smooth using the techniques of the invention, the motion field can be encoded very efficiently. Without this smoothness constraint, i.e., if the dense motion field estimation process simply attempted to find a motion vector for every pixel in the motion field by matching pixel data between frames, the resulting motion vectors would generally be going in many different directions and would therefore be very difficult to encode efficiently.

The specification thus specifically points out that an unconstrained dense motion field estimation process, which attempts to find a motion vector for every pixel in the motion field by matching pixel data between frames, is problematic. The present invention as set forth in independent claims 1 and

11 overcomes this significant problem by generating the motion estimate "at least in part as a constrained function of a characterization of motion between elements of the dense motion field and elements of one or more other portions of the image sequence." It is this constrained function aspect of dense motion field estimation that is called for in claims 1 and 11.

The Examiner in rejecting independent claims 1 and 11 under §102(b) argues that the above-described constrained function aspect of the present invention is disclosed at least in part in column 8, lines 1-7 of the Tekalp reference (Office Action, page 2, section 2). Applicants respectfully disagree. The portion of the Tekalp reference relied upon by the Examiner as teaching the constrained function aspect of claims 1 and 11 states as follows:

> For a new first image frame, first a motion segmentation algorithm is employed to determine the regions with different motions. Motion segmentation algorithms are known in the art, as for example, described in a publication by J.Y.A. Wang and E.H. Adelson, titled, "Representing moving images with layers," IEEE Trans. Image Proc., vol. 3, no. 5, September 1994, pp. 625-638.

Applicants submit that this portion of the Tekalp reference fails to provide any teaching whatsoever regarding the constrained function aspect of claims 1 and 11. The Examiner with regard to claim 11 further relies on FIG. 2A of Tekalp as teaching the constrained function aspect of the present invention. However, Applicants can find no specific mention of the claimed constrained function arrangement in FIG. 2A of Tekalp or the associated text. Even assuming for purposes of argument that Tekalp discloses a type of dense motion field based motion estimation, Applicants believe that it fails to teach the particular type of dense motion field based motion estimation set forth in claims 1 and 11, that is, one in which the motion estimate is generated "at least in part as a constrained function of a characterization of motion between elements of the dense motion field and elements of one or more other portions of the image sequence."

Applicants therefore submit that independent claims 1 and 11 are not anticipated by the Tekalp reference. Dependent claims 2, 3, 12 and 13 are believed allowable for at least the reasons

identified above with regard to their respective independent claims. Applicants respectfully request withdrawal of the §102(b) rejection.

Independent claims 21 and 24 stand rejected as being anticipated by O'Rourke. Applicants note that each of these claims calls for, in encoding an image sequence, generation of an estimate of apparent motion within the sequence, "wherein the estimate is generated at least in part utilizing a Markov random field (MRF) model to characterize motion between a given pixel of a motion field and one or more neighbor pixels." The Examiner argues that such an arrangement is disclosed in O'Rourke. Applicants respectfully disagree. The Examiner cites column 4, line 67 to column 5, line 15 of O'Rourke in conjunction with FIG. 7 as providing the teachings (Office Action, page 4). However, the Examiner has apparently failed to appreciate that the reference to Huber Markov random field (HMRF) in the column 4, line 67 to column 5, line 15 portion of O'Rourke relates to decoding of a previously-encoded image sequence, and not to encoding of the image sequence as claimed. This is apparent from column 4, lines 53-58 of O'Rourke, which states as follows, with emphasis supplied:

> The decompression techniques implemented in the present invention will now be described in detail. To decompress the compressed image representation, a maximum a posteriori ("MAP") technique is used. The decompressed full resolution image is represented by z.

It is therefore clear that the cited passage relied on by the Examiner in formulating the §102(e) rejection relates to the use of the HMRF in a decoding process. Moreover, Applicants note that the motion estimation process implemented by FIG. 7 of O'Rourke is a type of conventional block-based motion estimation, such as that described by Applicants in the background portion of their specification. This is apparent from column 10, lines 7-62, wherein it is more particularly stated at lines 41-43 that "the motion estimator 755 generates a motion vector . . . for each block or macro-block of the current frame." O'Rourke therefore teaches block-based motion estimation, and fails to teach or suggest the claimed generation of an estimate of apparent motion within an image sequence, "wherein the estimate is generated at least in part utilizing a Markov random field (MRF)

model to characterize motion between a given pixel of a motion field and one or more neighbor pixels."

Applicants therefore respectfully submit that independent claims 21 and 24 are not anticipated by O'Rourke. Dependent claims 22, 23, 25 and 26 are believed allowable for at least the reasons identified above with regard to their respective independent claims. Applicants respectfully request the withdrawal of the §102(e) rejection.

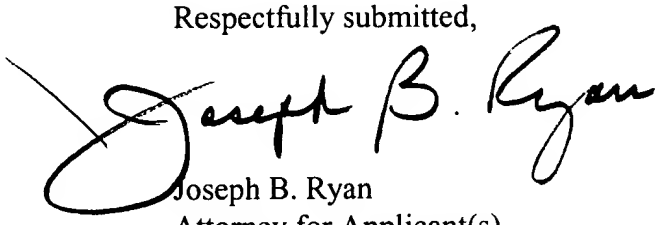
With regard to the §103(a) rejection of dependent claims 4-8 and 14-18, Applicants initially note that each of these claims is believed to be allowable for at least the reasons identified above with regard to their respective independent claims.

Furthermore, with regard to claims 4 and 14, these claims relate to a characterization of motion in motion estimation of an encoding process. As indicated above, the reference to HMRF in O'Rourke relates to a decoding process. Applicants therefore submit that there is no motivation for the combination proposed by the Examiner. In other words, one skilled in the art would not be motivated to take an element of the decoding teachings of O'Rourke for use in the encoding process as claimed, particularly in view of the fact that O'Rourke itself fails to use the HMRF in its encoding process.

Similar arguments apply for at least dependent claim pairs 7, 17 and 8, 18. For example, the limitation regarding a MAP estimation problem with a constraint on entropy as set forth in claims 8 and 18 is not met by the use of MAP estimation in decoding as taught by O'Rourke. The Examiner is taking decoding teachings from O'Rourke and arguing that they are readily combinable with the encoding process of Tekalp. However, there is no motivation identified for taking the O'Rourke teachings out of their decoding context in this manner. Applicants therefore believe that the §103(a) rejection is improper, at least to the extent it is based on decoding teachings from O'Rourke, and the rejection should be withdrawn.

In view of the foregoing, Applicants believe that claims 1-26 are in condition for allowance, and respectfully request the withdrawal of the §102(b), §102(e) and §103(a) rejections.

Respectfully submitted,



Date: June 28, 2002

Joseph B. Ryan
Attorney for Applicant(s)
Reg. No. 37,922
Ryan, Mason & Lewis, LLP
90 Forest Avenue
Locust Valley, NY 11560
(516) 759-7517